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Coastal Inlets Research Program

# Waves at Navigation Structures

Description

This work unit develops, validates, and implements advanced numerical wave modeling technologies which provide the USACE reliable and accurate wave estimates, and evaluates wave processes affecting navigation projects, coastal inlets and channels, ports and harbors and coastal beaches. It conducts basic research on coupling these wave models with flow and sediment transport models to calculate waves and currents for design and operation of channels, jetties, ports/harbors, and coastal morphology change. This work unit develops capabilities for meteorological and oceanographic data analyses that are necessary for short- and long-term simulations of coastal inlet hydrodynamics and navigation processes, and implements these technologies in the form of web-based tools, WaveNet and TideNet. It continually upgrades the Coastal Modeling System's (CMS) wave model CMS-Wave, a phase-averaged spectral wave model, and BOUSS-2D, a Boussinesq-type nonlinear wave model. These models are required for calculation of waves over shallow reefs and porous structures with variable roughness, infra-gravity waves, runup/overtopping, and wave asymmetry. Functional performance of USACE navigation projects can be evaluated with these models when coupled to flow and sediment transport models. Using laboratory and field measurements, the work unit verifies and validates the upgraded models for release to users. The work unit is developing WaveNet and TideNet, two web-based toolss to access, visualize, and process wind, wave, and tide data for USACE project applications and R&D needs.
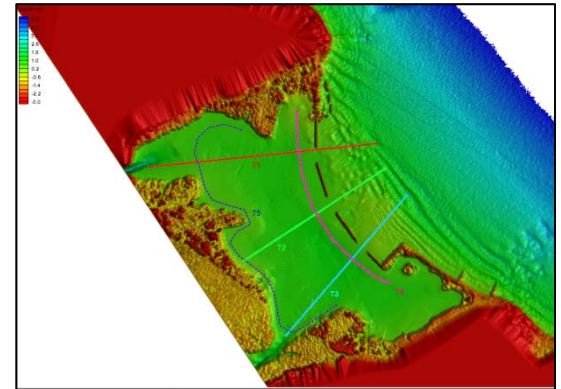
CMS-Wave application at Braddock Bay, NY

Issue Addressed

This work unit provides USACE wave technology and data, and develops guidance to maintain coastal navigation and port infrastructures nationwide. These advanced modeling capabilities provide improved wave predictions for projects at inlets, channels, ports/harbors, jetties/breakwaters, and estuaries. Wave interaction with inlets, channels, structures, shorelines, and varying bathymetry require calculation of wave reflection, diffraction, transmission, runup and overtopping to assess navigation safety and potential breaching or flanking. Infra-gravity waves causing harbor seiching and wave asymmetry in the surfzone can mobilize sediment transport at inlets and ports. Advanced wave models provided by this work unit address these critical needs of the Corps' navigation mission.
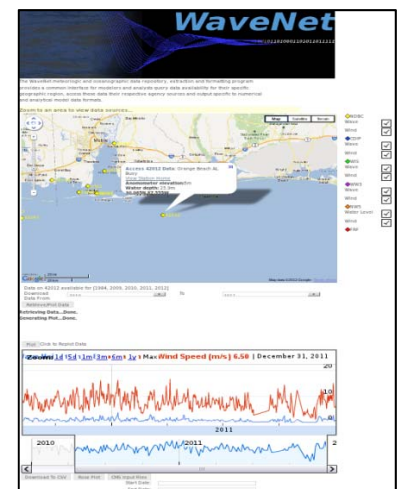
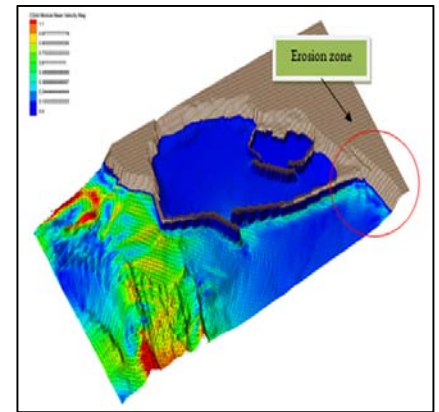WaveNet application in Gulf of Mexico

| **Products** | CMS-Wave and BOUSS-2D are two numerical wave models, and WaveNet and TideNet are two web-based meteorological-oceanographic (metocean) database access, process, and analysis tools. |

Application of Products

Ambrose Entrance Channel, NY; Braddock Bay, NY; Tangier Island, VA; Norfolk, VA; Popular Island, MD; Cleveland Harbor, OH; Duluth Harbor, MN; Sand Island, WI; St. Augustine Inlet, FL; Cape Canaveral Harbor, FL; Mississippi Sound, MS; Terrebonne Bay, LA; Galveston Bay, TX; Matagorda Bay, TX; Hilo Harbor, HI; Kikiaola Harbor, HI; Dana Point Harbor, CA; Pillar Point Harbor, CA; Ocean Beach, CA; Noyo Harbor, CA; Port Orford, OR; Tillamook Bay, OR; Mouth of Columbia River, OR/WA; Grays Harbor, WA; and others.

Projected Benefits

Products from this work unit include guidance, desk-top models, and web-based tools to evaluate waves at inlets, channels, coastal structures, adjacent beaches, ports, harbors, bays and estuaries. The improved wave modeling technologies provide more accurate and cost-effective engineering solutions to reduce operation and maintenance (O&M) costs within the navigation mission area. Web-based tools WaveNet and TideNet allow analysis, formatting, and downloading of wind, wave, current and water level data for use in report-quality documentation, desk-top analysis, and numerical modeling studies of coastal regions. Modeling capabilities are utilized to perform short- and long-term simulations of coastal

BOUSS-2D application at Half Moon Bay, CA

inlet hydrodynamics and nearshore wave processes in practical applications. These capabilities facilitate optimization of innovative infrastructure for navigation systems to improve the safety and reliability, maintain or improve environmental conditions, and reduce costs associated with design and operation of USACE navigation systems. The advanced models develop probabilistic engineering design estimates for rehabilitation of coastal structures to evaluate the impacts of routine engineering activities (e.g., dredging, channel deepening and realignment, and jetty modifications) on navigation and port utilization, and quantify ship transit wake effects at coastal and bay shorelines.

Documentation

Model documentation includes technical reports and a series of technical notes describing numerical model theory, numerics, verification and validation examples, and step-by-step user's guidance on interface and applications of models. Numerous journal and conference papers provide additional information about technology developed by this work unit. Publications are available from the CIRP website and open literature.

Points of Contact

Dr. Lihwa Lin, Lin.Lihwa@usace.army.mil, and Dr. Zeki Demirbilek, Demirbilek.Zeki@usace.army.mil

CIRP Website

- Please see the CIRP website to download documentation:
  http://www.erdc.usace.army.mil/Missions/WaterResources/CIRP/Publications.aspx
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